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BOOK REVIEWS AND NOTICES*

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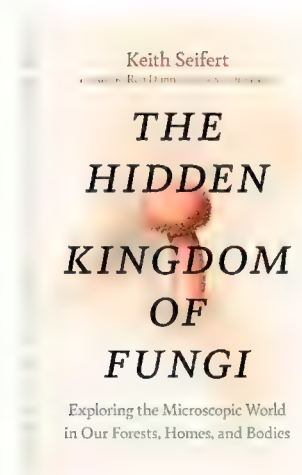
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ABSTRACT—Books reviewed include GENERAL—The Hidden Kingdom of Fungi (Seifert 2022) and BASIDIOMYCETES—The boletes of China: *Tylopilus* s.l. (Chun & Yang 2021).

GENERAL

The Hidden Kingdom of Fungi—Exploring the Microscopic World in Our Forests, Homes, and Bodies. By Keith Seifert. 2022. [Greystone Books, Vancouver/Berkeley/London. 280 p. with line drawings, hardback. ISBN 978-1-77164-662-8 (cloth); ISBN 978-1-77100-663-5 (epub). Price (excl. postage): CAD34.95; USD27.95]



Fungomorphism rocks! (Or so I am now persuaded.) After leaving the art world to return to school 35 years ago for formal biological training, I was warned by Botany Professor Ed Lippert that scientists must not think ‘teleologically,’ inferring a purpose or design from natural phenomena where there was none. Imparting human feelings to life forms was right up there with falsifying experiment results. However, as Keith Seifert notes in his introduction, “Interpreting the behavior of

* Book reviews or books for consideration for coverage in this column should be sent to the EDITOR-IN-CHIEF <editor@mycotaxon.com> 6720 NW Skyline, Portland OR 97229 USA.

other living beings as equivalent to human cognition, emotion, or agency is anthropomorphism. In science, this is often considered an unforgiveable error. But the very notion of anthropomorphism seems anthropomorphic. We too are locked into our version of existence by our senses and consciousness. Anthropomorphism is the best tool we have to imagine creatures that are so dissimilar [as fungi].... To imagine our world from the point of view of a fungus is a challenge, but because this book is about fungi, I will be unapologetically fungomorphic." Seifert proceeds, describing the fungal kingdom as seen through the eyes of fungi. The knowledge dispensed during his journey is eminently accessible and endlessly fascinating. That it is comprehensive is only to be expected by someone with Keith's impressive background and experience.

A forward by Rob Dunn sets the stage: "Mycology is a dark art. Mycologists perceive things that others miss. They traffic in the scarcely visible." There follows "A note about names" where Keith trenchantly observes that trying to master fungal names is like "trying to follow characters in a Russian novel" [especially given their mutability and transience during this age of molecular discovery]. He rightly observes that students should use the names more as a "phone book for looking up the evolutionary address of the fungus"—a way to discover where a fungus began and where it might be headed. In his 10-page Introduction ('Diversity in the dust'), the former President of the International Mycological Association briefly covers his early life to explain how he ended up as an integral part of the 'Fungal Umwelt.' The remaining book, with lovely line drawings scattered here and there, is divided into three parts.

PART I: THE HIDDEN KINGDOM (pp. 13–57) begins with 'Life in the colonies' (1), which tackles fungal evolution from the beginning: "Life appeared about four billion years ago during the geological period we call the Precambrian Era. For the first two billion years, sometimes disparaged as the Boring Billions, all life forms had just one cell." The next 21 pages pull us forward from those one-celled critters to fungi with so many mating variants that "if you count each combination of variants as a different gender and do the math for some species, you end up with 23,000 genders." A lot of complexity to introduce in these first pages, but Keith does it magnificently. 'Life on the commons' (2: mutualism/ parasitism/ biological invasion) shifts from life forms to life strategies, exploring the various types of symbioses and antagonistic interactions. (Two favorite subheadings in this chapter: 'Commensalism: friends without benefits' and 'The gray margins: parasitic symbionts or pathogens?')

PART II: THE FUNGAL PLANET (pp. 57–174): the chapters covering (3) forests, (4) farming, (5) fermentation, (6) ‘the secret house’ (indoor environments) and (7) “holobiont (‘the mycobiome and the human body’) comprise the meat of the book and are packed with an impressive amount of information. My knowledge of endophytes was limited to discovering in the late 1990’s that DNA conifer phylogenies were in reality phylotrees of *Lophodermium* (here nicknamed ‘lopho’), endophytes universally present in pine needles. “Once DNA barcoding came along, we were shocked to discover that among all the cultures and DNA barcodes directly retrieved from plant tissue were thousands of species of endophytic fungi.” One reviewer was saddened that only six and a half pages covered the endophytic fungi in forests in this book, but those pages broadened my knowledge considerably. Also discussed are epiphytes, endo-/ecto-mycorrhizae, *Armillaria* and other endemic tree diseases, the discovery and battle against the Dutch Elm disease (DED), the more restorative process of decay and nutrient cycling overseen by fungi, and the potential use of endophytes in biological control.

“Farming” (the ‘seventh oldest profession’) focuses on the “artificial ecologies created over centuries, as farmers tilled their soil, planted seeds, prayed for sun and rain, and agonized over failed crops long before the causes were understood.” In their drive to produce ever larger yields, farmers managed to so alter the natural environment (killing off the beneficial fungi) that they “unwittingly disrupted many of the original biological connections.” Here endomycorrhizal fungi (of the *Glomeromycota* and *Mucoromycota*) with their arbuscles and vesicles come into their own. “Unlike most ectomycorrhizal fungi, AM fungi have a promiscuous, open-arms policy towards their plant partners and form symbioses with many different plants. Thousands of plant species rely on only two or three hundred species of AM fungi.” Next come the rusts: ‘Rust Never Sleeps’ presents a detective story of how agriculturalists sought rust (*Puccinia graminis*) control through eliminating the alternate hosts (wheat and barberry) and now confront the problem of warmer climate and the tendency of *Puccinia* to develop new pathogenic races (including Ug99, from Uganda) which scientists are developing resistance strains to combat. Also covered are aflatoxins (according to some estimates, aflatoxin kills more people than malaria), vomitoxins (*Fusarium*, causing highly toxic ‘tombstone kernels’ in affected maize), and the more benign *Beauveria* and *Nosema*, now being developed as biocontrols of harmful insect pests.

Bring on the beer!! ‘Fermentation’ covers food, drink, and compost, introducing what Seifert calls the sacred fungal trilogy of ‘wine, cheese, and

chocolate.' Chocolate and coffee would not taste so delicious if they were not transformed by yeasts (and bacteria) to develop their "distinctive flavor and aroma."

'The Secret House' moves fungi indoors and into the 'built' environment. At one time Keith would go 'field' collecting with his vacuum cleaner in houses to record whatever species he could find. Anyone who has contended with *Serpula lacrymans* (dry rot) in the walls and beams or *Stachybotrys* black moulds in damp buildings knows that fungi are as at home in houses as in the outdoors. Seifert notes, "The meaningful biological divisions among fungi in the built environment are between moulds causing decay; moulds that amplify in wet places; moulds that amplify in dry places; and moulds causing allergies. Each zone of a house has its own guild of fungi that affects us in various ways." He points to house dust as the 'most conspicuous domestic reservoir of moulds.' Earlier researchers estimated that western homes harbored about ~100 fungal species (with only 40–50 in any one building), but when Seifert barcoded the fungi in his house's central vac system, his few tablespoons of dark gray powder scooped into sealed plastic bags yielded ~600 fungal species, including plant pathogens blown in from the yard, yeasts and moulds actively spoiling food, soil fungi, along with 'typical' house dust fungi. "The clear signals of conifer endophytes were a puzzle until a picture of our Christmas tree slid across my computer's screen saver and reminded me of all the needles vacuumed off the floor. There was also the faint signal, just three sequences of a poisonous *Amanita* species only ever seen in Japan. How did that get there?" In suggesting strategies to combat some of the more toxic fungi, Keith discourages using bleach, which dries into crystals that 'irritate the lungs and could be more troublesome than the fungus you are trying to get rid of.' He ends this chapter with the cheerful thought: "The reality is that our buildings—like trees, crops, and humans—are mortal. Over time, saprobic fungi will turn all of our built environments into compost." Sic transit gloria.

Part II concludes with the "holobiont" and the Human Microbiome Project that investigated the microbes on and in our bodies. As "walking ecosystems," humans are not exempt: "Almost every living thing big enough to see—wild and domesticated animals, reptiles, fish, and all our friends and relatives—is a collection of symbionts.... Russian matryoshka nesting dolls must have been inspired by microbiology." We know that "bacteria contribute an extra 50,000 genes to keep our systems functioning," but Seifert feels that the contributions from fungal genes tend to be downplayed; he also points out that really only a tiny proportion of the millions of bacteria and fungi in our environment

are harmful, and that a healthy microbiome naturally balances the competing interests of individual microbes. One fascinating pearl of wisdom is that yeasts (*Melasezzia*) serve as skin protectors as well as sparking bothersome dandruff and (when things get out of balance) itchy eczema. *Candida* is believed to assist digestion, although as candidiasis it usually is blamed for pathogenic reactions (thrush) and hospital contamination.

PART III: THE MYCELIAL REVOLUTION (pp. 177–218) presents two call-to-arms chapters. I confess to eyes glazing over somewhat during parts of ‘Mycotechnology’ (8), covering fungal involvement in the development organic aids, plastics, and enzymes, “mining” for drugs (the ever-fascinating Fleming-Florey-Chain-Mouldy Mary *Penicillium* saga and the development of cyclosporin), and mycoremediation, primarily because here the author preaches to the choir. Nonetheless he presents an effective call to action on how fungi can assist humans in restoring an increasingly elusive natural order. ‘Thirty Thousand Feet’ (9: fungi and the sustainable planet) tackles the problems presented by overpopulation, climate change, and all manner of political mayhem. This chapter is concluded by a rousing “The future is fungal. It is also bacterial, algal, protistan, viral, buggy, wormy—full of all sorts of creatures, the big and beautiful, the small and ugly. Most of the life-forms around us were here long before we arrived and will remain long after we are gone. Let’s learn what we can from them and hope for a long, rich journey together.”

THE HIDDEN KINGDOM OF FUNGI concludes with the ‘Acknowledgments’ (pp 219–20), ‘Appendix: Fungal classification’ (pp. 221–31), ‘Notes’ (pp. 233–46), ‘Literature cited’ (pp. 247–64), and ‘Index’ (pp. 265–80). The ‘Appendix’ hits the high points of 2022 taxonomic/phylogenetic interpretations. Being a bit long in the tooth and decidedly species oriented, I customarily do not pay much attention to higher level taxa, so these ten pages were a bit of a welcome eye-opener (When did *Neocallimastigomycota* become a phylum? Sorry, Martha!) The Notes mix together fascinating tidbits and references. As a reader, I prefer notes placed at the bottom of the page but know from bitter experience that setting footnotes is a thankless task that modern editors and ‘type-setters’ avoid at all costs. I did miss text references placed in this section rather than in the running text; this particular placement frustrated my friend Jan (a just-the-facts reader and definitely not a fan of anthropomorphism), who really wanted to know the source of the information while reading. On the other hand, those unaccustomed to reading scientific papers truly despise finding a text reference plumped into the middle of the line, thus interrupting a really good story, so this

is probably the best compromise. Reading the notes all together before (and/or after) each chapter proved a good solution and drew attention to information that might have otherwise gone unnoticed.

Since 1992, I have had the supreme good fortune of knowing Keith and his friend Andy Mackinnon, two parts of the irreverent Rot Nots crew (their friend Richard Summerbell being the third), and have long forgiven Keith for once referring to this esteemed journal as “MYCOTOXIN” (which probably amused me more than it did founder Dick Korf). It’s comforting to discover that the early Rot-Nots irreverent wit has sparked a book that everyone—mycologically trained or otherwise—should have on their bookshelves.



<—A different cover in Australia

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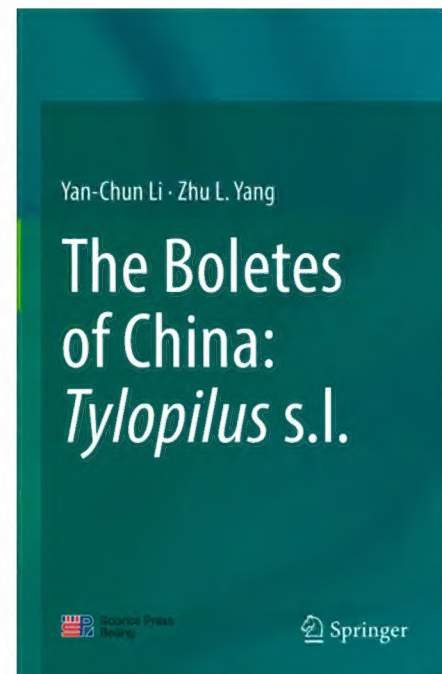
The Boletes of China: *Tylopilus* s.l. By Yan-Chun Li & Zhu L. Yang. 2021. [Springer, Address. 418 p. with plates & line-drawings; ISBN 978-981-16-2985-3 (hardcover \$159.99, excl. postage) ISBN 978-981-16-2986-0 (eBook: \$119). <https://doi.org/10.1007/978-981-16-2986-0>

The new BOLETES OF CHINA is another testimony to the diversity and richness of bolete species in China. The focus here is on species with a pallid to pinkish, purplish pink, or red to reddish brown hymenophore and spore print; in other words, species that in the past would have been reckoned to the genus *Tylopilus*. These are here classified in a total of 19 genera, two of which are described as new to science. These 19 genera fall into five different subfamilies of the *Boletaceae*, so indeed, *Tylopilus* in the old sense, is polyphyletic to the nth degree.

To put this in perspective, new genera were also recently described for species in South America that conform to the traditional concept of *Tylopilus* (Magnago & al. 2022).

Chun & Yang, authors of the present book, state that in China alone many species that would have been assigned to *Tylopilus* sensu lato are still undescribed and await discovery, despite the fact that more than 100 species are covered here.

The book follows the traditional canvas of a taxonomic treatment: an introductory chapter, chapters on materials and methods, morphological characters of taxonomic importance, the phylogeny based on an analysis of several gene regions, and the taxonomic parts in which each genus gets treated in its own chapter, with keys to genera and species, and good illustrations (photos



of all species in their natural habitat and—for the new species—line drawings of the important microscopical characters). A summary closes the book and of course a list of references and an index to the scientific names are present as well.

Of all the tylopoloid genera, with 32 species *Tylopilus* s.str. is the most species rich in China, of which 11 are described as new here. A wide variety of pileus and stipe colours are represented.

For many previously named species, new distribution data are provided that contribute important ecological information for taxa that often have been themselves only recently described. For instance, *Sutorius obscuripellis*, described in 2021 from northern Thailand, also grows in southern and southwestern China, and *Tylopilus himalayanus*, originally described from India is now also known to occur in several Chinese provinces.

This is a splendid effort to bring order to a group of species that at first glance might look very much alike. The authors can be congratulated on bringing the tylopoloids in such an organized manner to a wide public.

Magnago AC, Alves-Silva G, Henkel TW, Silveira, RM Borges da. 2022.

New genera, species and combinations of *Boletaceae* from Brazil and Guyana. *Mycologia* 114: 607–625.

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